I/UCRC Executive Summary - Project Synopsis	**Date**: October 2021
Center/Site: CANFSA/Iowa State University	
Tracking No.: Project 46: Influence of Microstructure on the Oxidation Behaviors of Refractory Complex Concentrated Alloys (RCCAs)	**E-mail :** njwelch@iastate.edu **Phone :** (515) 778 0450
Center/Site Director: CANFSA/M. Kaufman/P. Collins/A. Clarke	**Type: (Continuing)**
Project Leader: Noah Welch	**Proposed Budget**:

Project Description: The goal for this project is to better understand the influence of microstructure on the oxidation mechanisms of RCCAs so these properties can be engineered further. Multiple compositions in the TaTiCr RCCA system —TaTiCr, Ta_2TiCr, Ta_4Ti_3Cr, and Ta_4TiCr_3 (at%)— will be analyzed to understand compositional contributions to microstructure and oxidation properties.

Experimental plan: Four alloys with different composition from the TaTiCr system will be studied initially. Three ingots of each composition will be arc-melted and specimens will be machined to measure baseline oxidation behavior and observe microstructural changes between various annealed conditions. Compositionally graded, additive manufactured specimens will be heated using a Gleeble thermal-mechanical simulation system, to test oxidation properties rapidly.

Related work elsewhere: Scientists at the Air Force Research Laboratory (AFRL) at Wright-Patterson AFB have studied mechanical and oxidation behavior of many RCCA alloy systems. Further, a collaborative effort between scientists from AFRL, l'Institut de Chimie de la Matière Condensée de Bordeaux (ICMCB), and Stony Brook University produced a mechanical and physical property database of over 370 CCAs and HEAs from previously published work.

How this project is different: RCCA oxidation properties have not been thoroughly researched or well understood. Investigating microstructural effects on oxidation will elucidate how these alloys can be engineered.

Milestones for the current proposed year: Understand the influence of grain size, laves phase distribution, and surface conditions on the effect of oxidation behavior in alloys of varying compositions

Deliverables for the current proposed year: Detailed analyses of microstructure and congruent oxide structures of TaTiCr alloys as well as reported oxidation behavior of an ideal composition range.

How the project may be transformative and/or benefit society: With the ever-increasing demand for advanced materials, RCCAs show great promise for use in aerospace, defense, and other harsh environment applications. This research will be integral to a greater understanding of the RCCA class of alloys and provide a means to compare the properties of inter- and intraclass alloy systems.

Research areas of expertise needed for project success: Different microscopy techniques (optical, SEM, FIB and TEM) are needed for microstructure analysis across length scales. LENS system is needed to print additive manufactured specimens with specific chemistries. Gleeble thermomechanical system is needed for bicombinatorial oxidation studies.

Potential Member Company Benefits: Because the densities of these alloys are comparable and their inherent oxidation resistance is greater than that of Ni-based superalloys, a better understanding of oxidation properties of RCCAs will provide a framework to engineer the properties of these alloys and potentially substitute Ni-based superalloys as advanced, high-temperature, structural materials.	
Progress to Date: Specimens have been arc-melted, hot isostatic pressed (HIP), and sectioned via EDM for further experimentation mentioned in the experimental plan. As-cast and HIP microstructure have been analyzed and grain morphology and present phases have been compared to each other. EDM specimens were pickled to remove surface contamination. Unmixed tantalum was revealed in several specimens after this process. TGA oxidation tests are being planned and chemistry is being analyzed to observe any unforeseen changes due to the unmixed element.	
Estimated Start Date: Fall 2020	**Estimated Knowledge Transfer Date**: Spring 2024

The Executive Summary is used by corporate stakeholders in evaluating the value of their leveraged investment in the center and its projects. It also enables stakeholders to discuss and decide on the projects that provide value to their respective organizations. **Ideally, the tool is completed and shared in advance of IAB meetings to help enable rational decision making.**